# First Global Monthly TSI / SYNI /AVG @ SCF "Diurnally Resolved Radiative Transfer"

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*5th CERES-II Science Team Meeting*

*Crowne Plaza at Ft. Magruder, Williamsburg,Va.*

*May 2nd – 4th 2006*

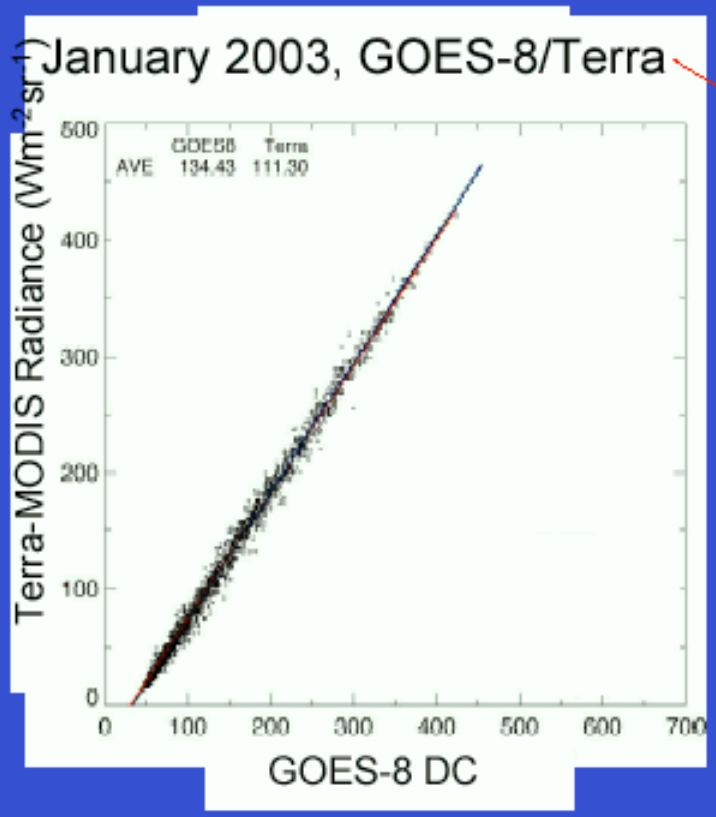
# TSI: Cloud & Toa Flux
## Inputs for SYNI "Synoptic Sarb"

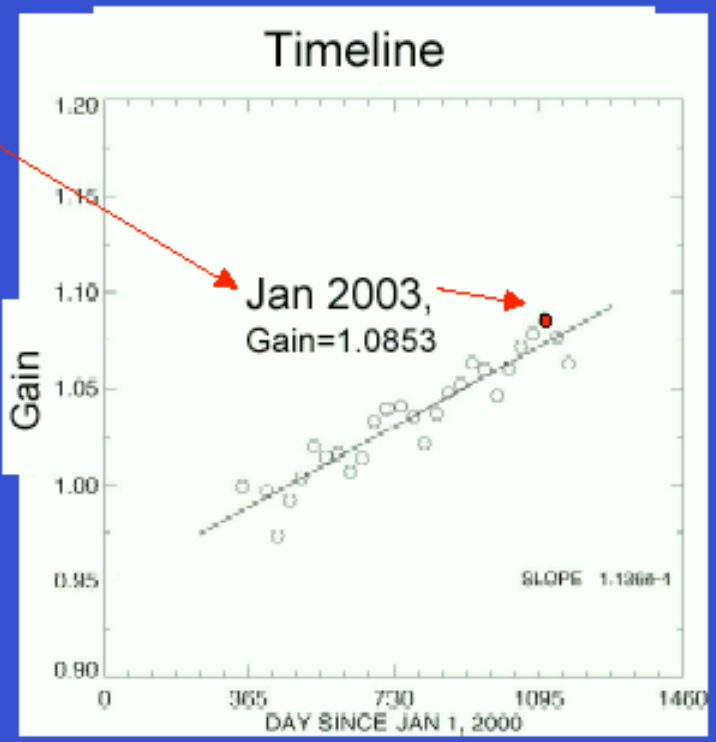
- TOA Flux
  - ~Twice daily CERES
  - 3 hourly GEOstationary Flux
    - narrowband to broadband
  - Other times interpolated
- Clouds
  - MODIS : ( Multi-channel)
    - Fraction, Optical depth , Height , Phase, Part. Size
  - GEOstationary : ( Vis & IR only)
    - daytime : Fraction, Optical depth, Height
    - night : Fraction , Height

# TSI : Calibrate GEO visible radiances against MODIS

- Geostationary Visible **not** calibrated onboard satellite
- Calibrate to MODIS over oceans to mitigate spectral response function differences between geostationary satellites
- Regress Co-located, Co-angled, Co-incident radiances within 15 minutes
- Validate by cross-calibrating geostationary satellite pairs

# GOES-8 visible calibration with Terra-MODIS




Degradation rate = 365*1.136e-4 = 4.15%/year

# TSI: Geostationary TOA SW Fluxes

- GEO Narrowband radiances converted to broadband
  - Modtran/Disort based ( S.Kato)
  - Based on angles, surface type, ozone, cloud amount, phase, optical depth and GEO satellite spectral response.
- Invert broadband radiance to broadband flux
  - CERES TRMM ADMs
  - Using GEO Cloud product
- Shortwave Flux is normalized to CERES observations ….

# Geo SW Normalization

- GEO clear-sky albedos are replaced with CERES
  - Land spectral differences are difficult to account for in GEO
  - No day to day variation in the clear-sky albedo
- Snow regions use the non-GEO method
  - GEO cloud properties over snow are suspect
  - Bright surfaces have little diurnal variation
- Perform regressions of GEO-derived and CERES matched SW fluxes
  - Slope and offset used to account for GEO visible calibration inadequacies and regional NB to BB variability
  - 5x5 surrounding regions and matches within 90 minutes
  - Regions are limited to GEO-satellite, and GEO-type
  - No glint matches are used
  - Regions with insufficient matches use 5° zonal regions

# TSI: Geostationary TOA LW Fluxes

- GEO satellites have onboard IR calibration
- IR radiances are converted to narrowband fluxes using simple limb darkening model
- Apply empirical NB->BB relationship which includes a water vapor term
  - Currently one regression will be enhanced in future editions.
- Normalize GEO derived interpolated fluxes with CERES at coincident times

# SYNI Product

- Hourly radiative transfer
  - Fu-Liou code
- CERES Equal Area grid (~1deg)
- TSI Cloud Inputs
  - CERES(12hr),+GEO(3hr) + Interpolated
- MOA Geos_4.0.3 Atmosphere
  - SMOBA Ozone
- Modis & Match Aerosols
- Grid Average Surface properties

# Fu-Liou Broadband Radiative Transfer

- Gamma weighted 2-Stream (SW) , 2/4 Stream (LW)
  - Treats sub-computational scale Inhomogeneous clouds ( S.Kato)
- 32 Bands : 18 SW, 14 LW , 3 of 14 LW in WN
  - Enhanced output of PAR and UVA,UVB (W.Su)
- Shortwave: ( 0.17 - 4.0 or *inf* )μ [0 or 2500-57000 cm-1]
  - HITRAN 2000 ( $H_20$ ) w/( $O_2$,$CO_2$,$CH_4$)Fixed
  - JPL(1994) $O_3$ uv , WMO(1985) $O_3$ vis
- Longwave (0-2850cm-1) (3.5μ – Infinity )
  - $H_20$ ,$CO_2$ ,$O_3$ ,$N_20$ ,$CH_4$ ,CFCs, H20 continuum )
- Optical Properties: spectral ( β, ω , g )
  - Water Cloud (Y.Hu)
  - Ice Cloud ( Q.Fu 1996 ,Dge)
  - Aerosol Optical Properties
    - OPAC, Tegin&Lacis, d'Almedia
- Major Revisions
  - 10 visible SW bands reworked for $O_3$ and rayleigh in 1995
  - Near-Ir 0.7-1.3μ subdivided into 4 bands in 2005
- Online Version http://www-cave.larc.nasa.gov/cave

# SYNI Surface Optics

- **Scene Id**:
  - IGBP
  - Daily Snow Ice maps ( NSIDC microwave)
  - Threshold of Cloud WG Daily 0.63 & 1.6 overhead sun albedo
- **Broadband Surface Albedo:**
  - COART ocean surface albedo via look up table
    - (tau, solar zenith angle, windspeed)
  - Clear land+snow
    - CERES TOA with LaRC Fu-Liou atmosphere correction LUT
  - Cloudy land: monthly min clear sky albedo
    - diurnal model
- **Spectral Albedo Shape**
  - COART (Ocean,Snow,Sea Ice)
  - CARE Experiment (grassland), Bowker ( all other IGBP types)
- **Emissivity**
  - Cloud WG 12 month seasonal maps (3 window bands)
  - SOFA ( IGBP based for other LW bands)

# SYNI Aerosols

- MODIS ( MOD04)
  - multi-channel AOT ( 7 wavelength ocean, 3 land)
- MATCH Daily Assimilation
  - Constituents
    - Small & Large Dust, Sea Salt, Sulfate, Black Carbon, Hydrophilic & Hydrophobic organic carbon
    - Basis for assignment of optical properties ($\beta$,$\omega$,g)
      - Tegin&Lacis , OPAC
    - MATCH optical depth used over high albedo land or ocean sunglint where MODIS AOT's not available
  - Vertical profiles

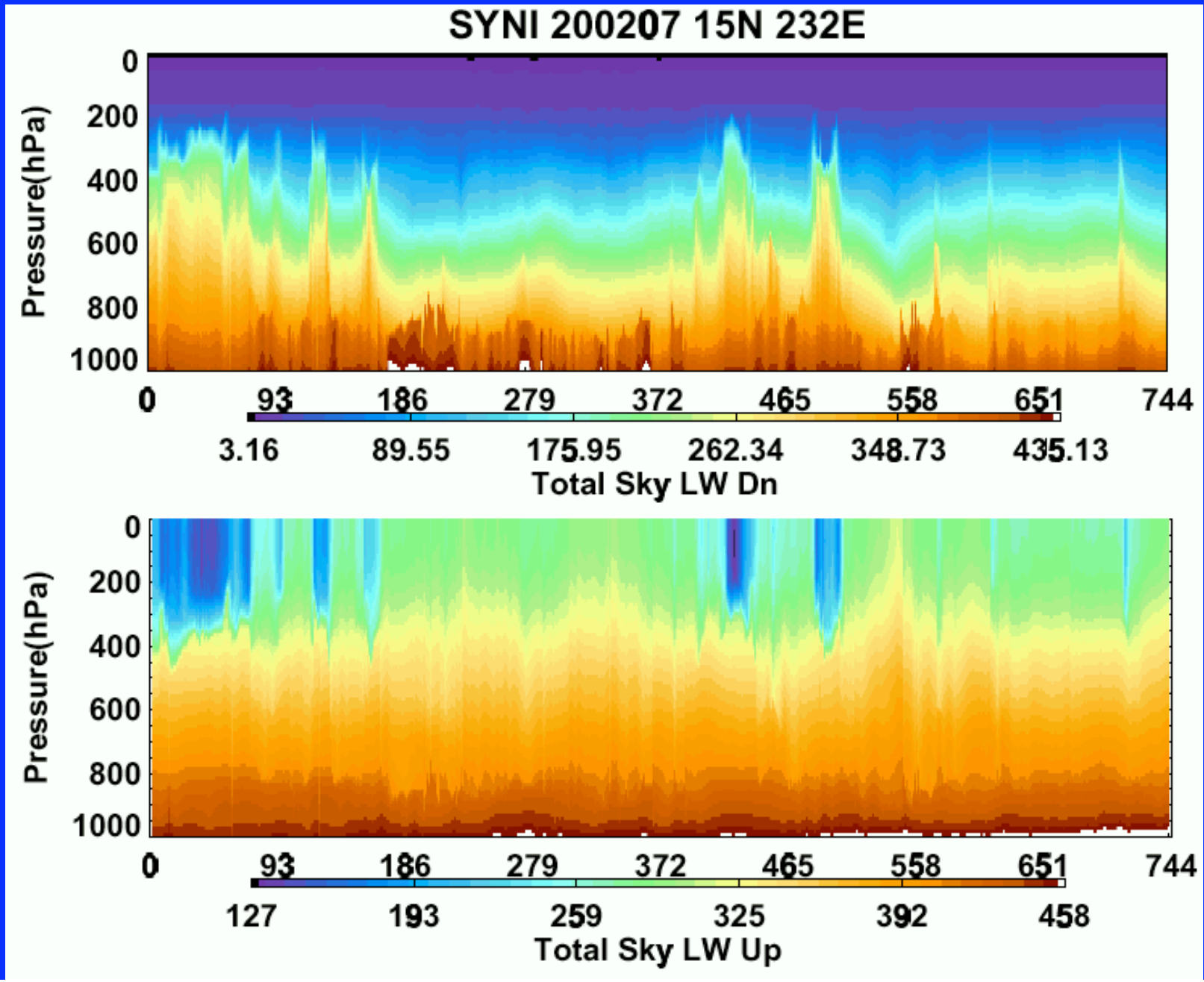
# First Run Issues

- First full end to end run attempt at SCF
  - FSW →TSI →SYNI → ZAVG → AVG
  - Data month July 2002
- **TSI:**
  - Unintended use of LOCAL time **not** GMT reference frame !!
  - Will add MODIS AOT's
  - Will add Clear Geo Radiances for skin temperature retrieval
  - Will revise record indexing to Equal Area to reduce file size
- **SYNI:**
  - CRS like NOT grid averaged )Surface Optical properties
  - No MODIS Aerosol were available on TSI file
    - Instead used Stowe single wavelength AOTs over ocean
  - GMAO GEOS4.0.3 6 hourly skin temperatures used
    - 3 hourly to be used in future runs
  - 36 model level output ( huge file sizes )
    - 5 level in future runs (toa,70,200,500,.sfc)

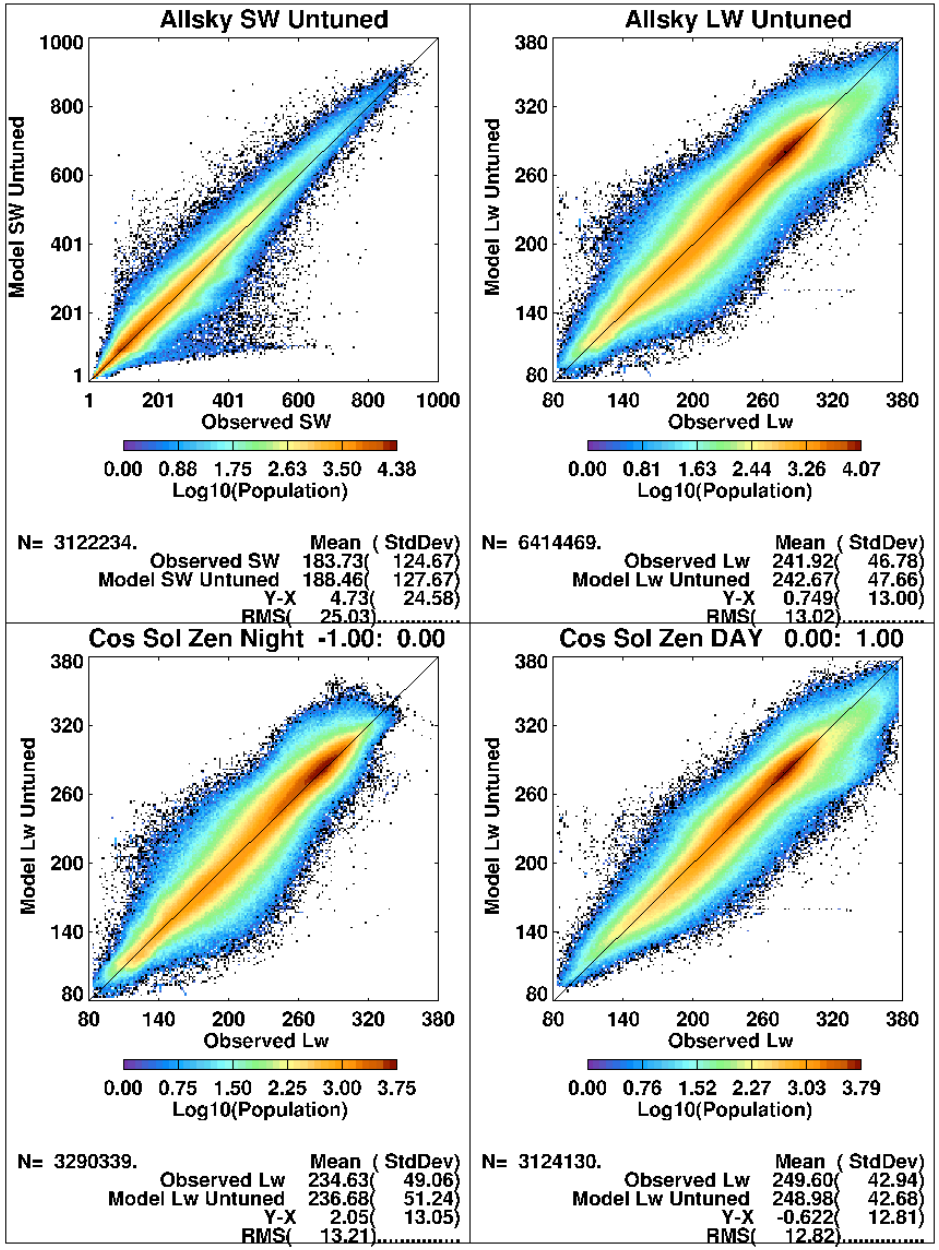
# First Look at SYNI Data

- Example time-height flux profile
- Scatterplots
  - Subset ( 5 deg in latitude)
- Global Maps
  - TSI, SYNI, SRBAVG
  - NOT from AVG Product

# Example Time Height Profile Longwave Flux ( 36 level data)



Synoptic Sarb
200207Z (90S :90N: by 5
(proc:Mar 14th 2006 SGI )



Synoptic Sarb
200207Z (90S :90N: by 5
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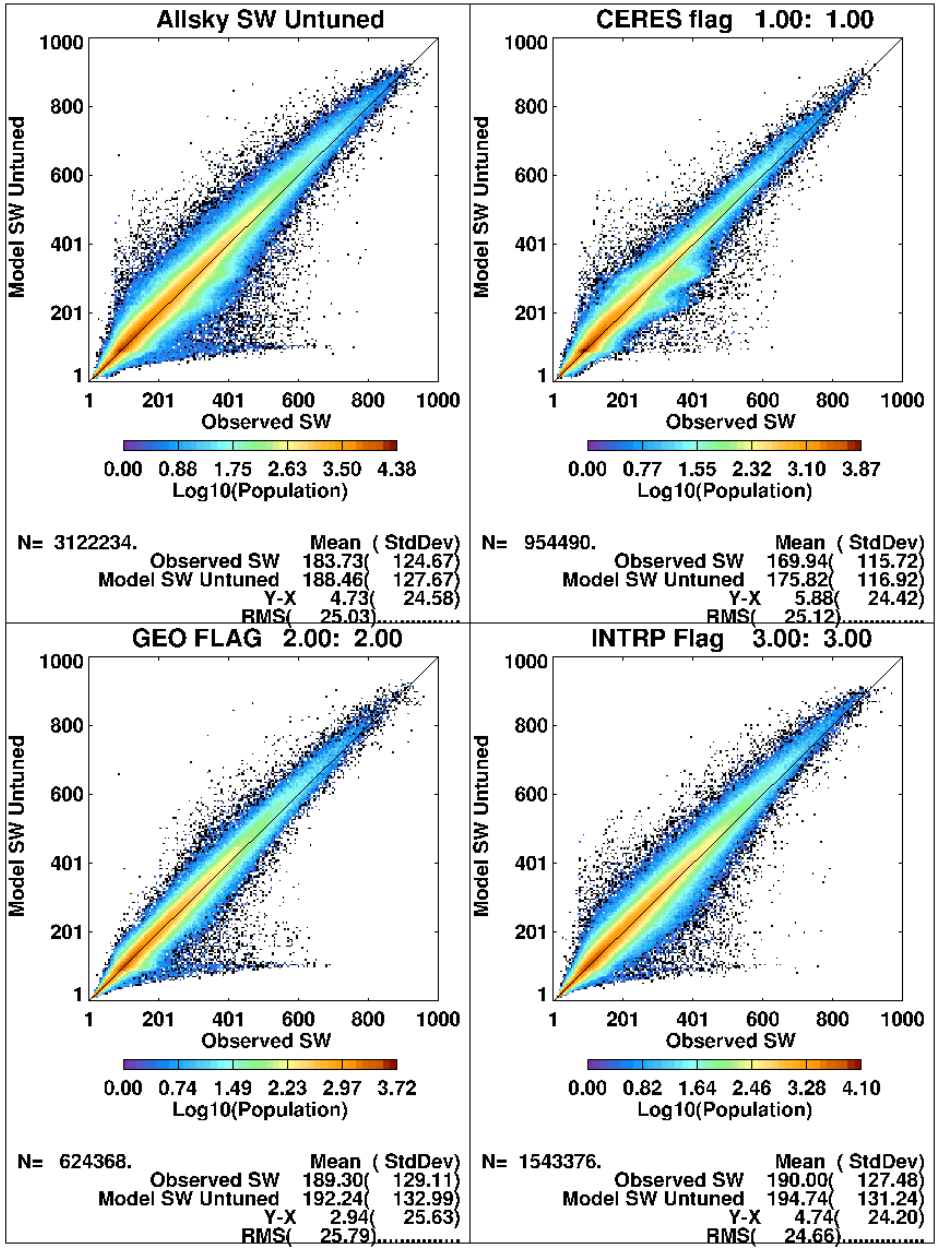


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Synoptic Sarb
200207Z (90S :90N: by 5
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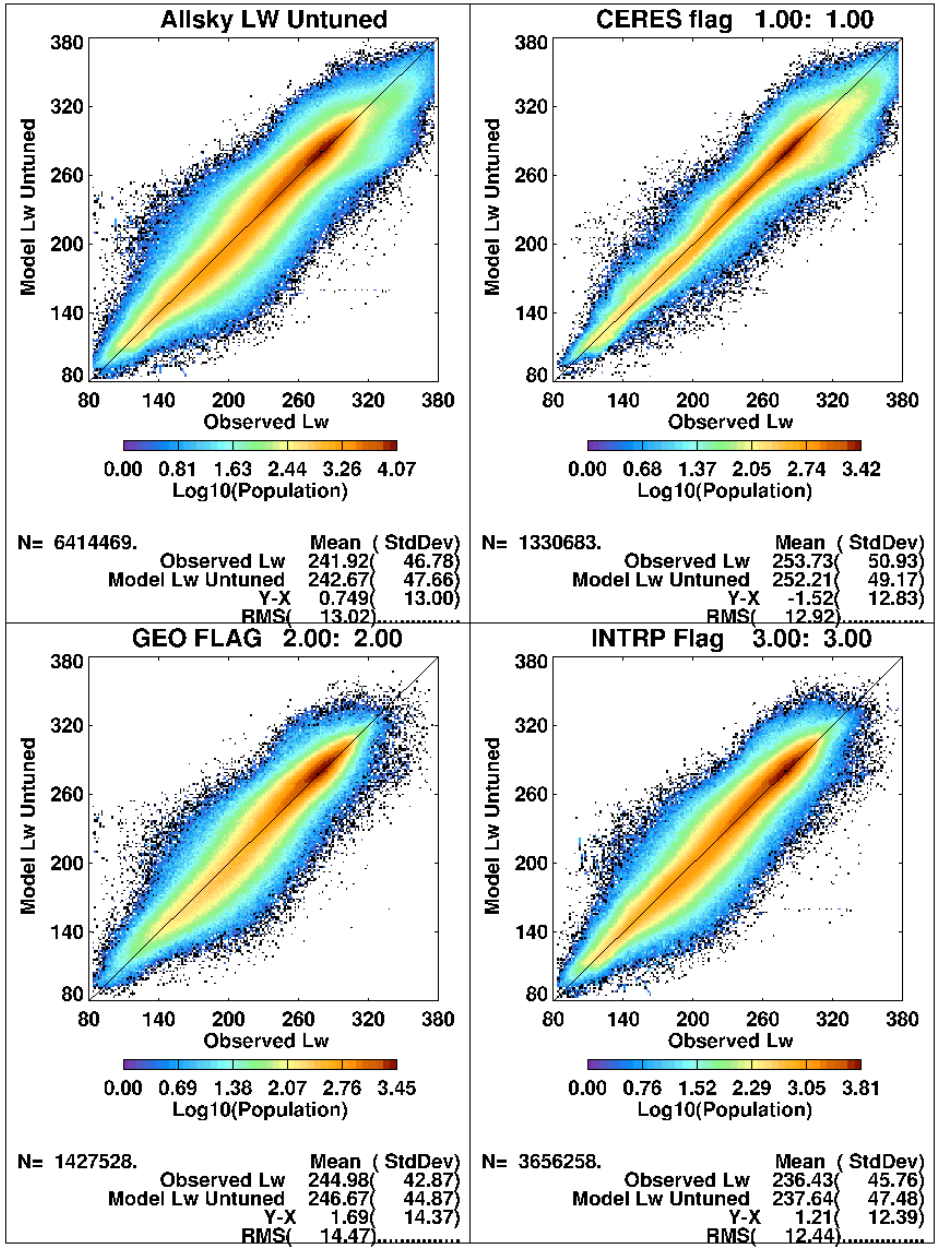

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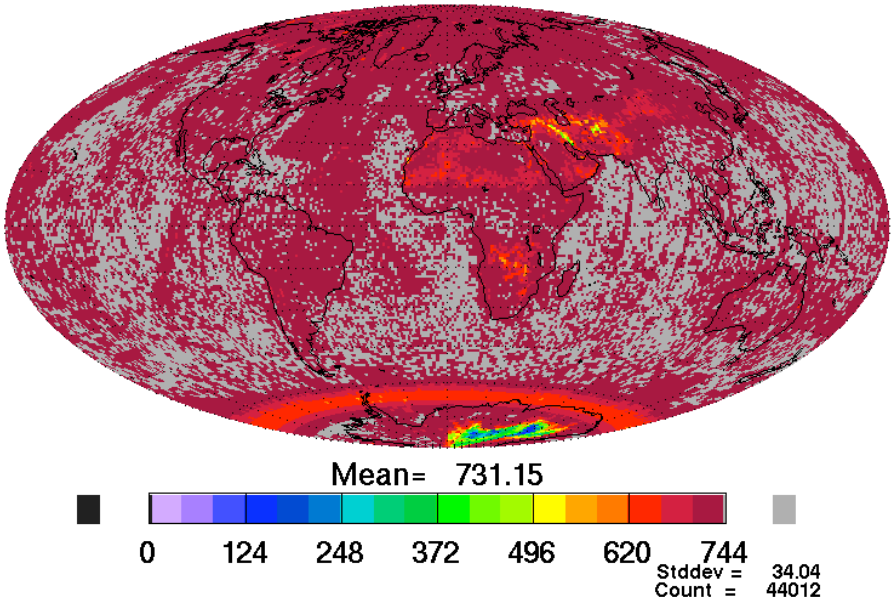


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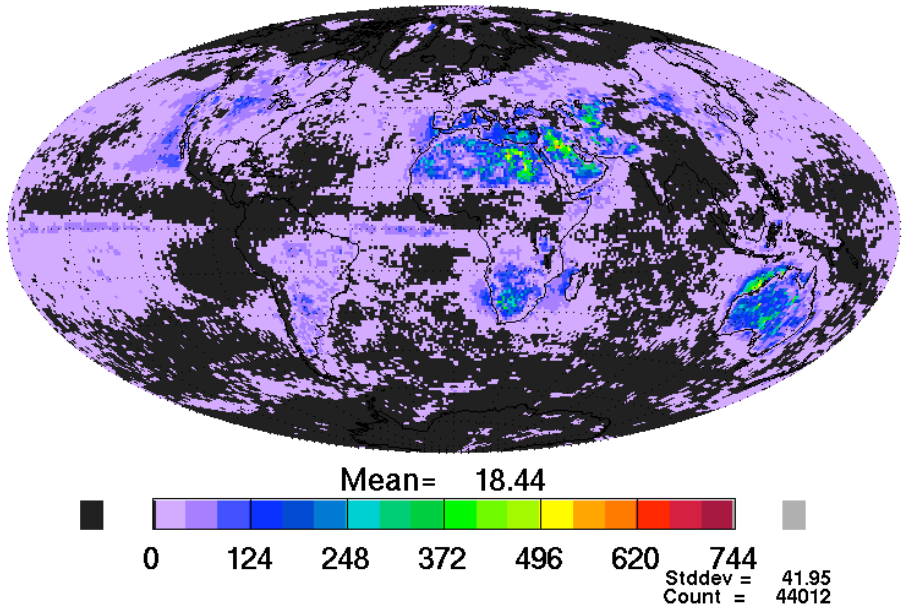


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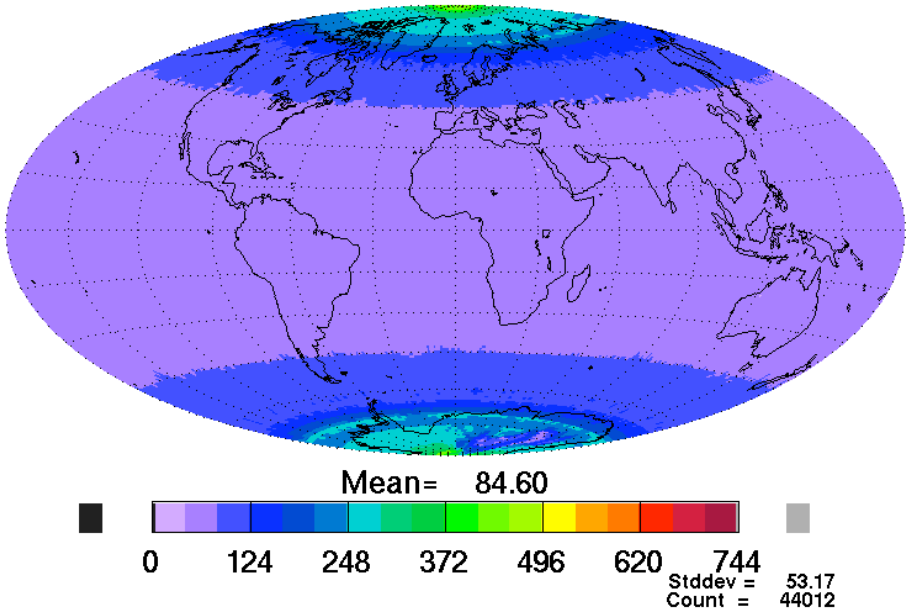


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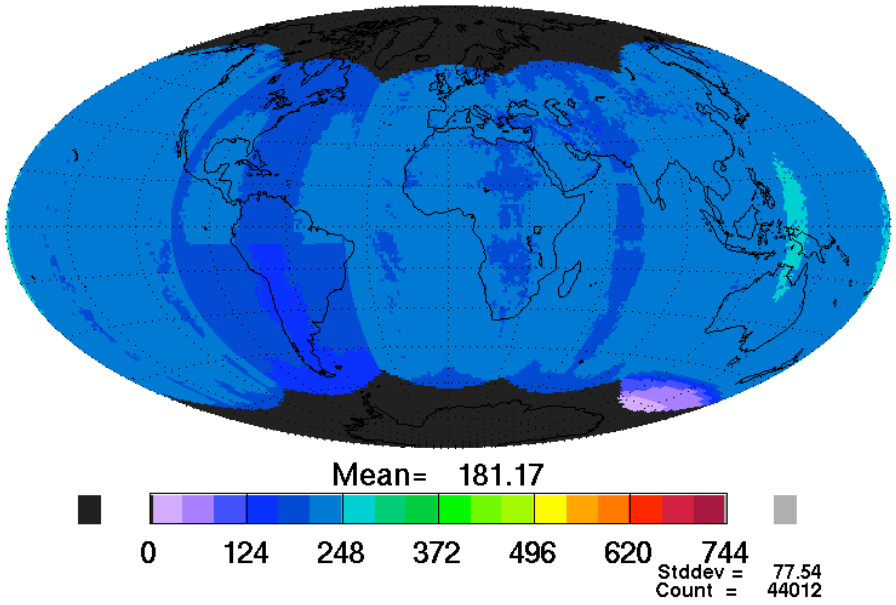
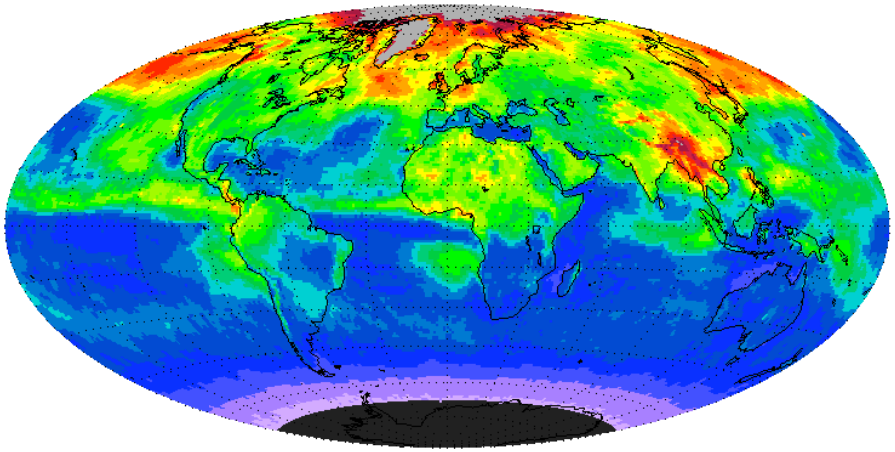
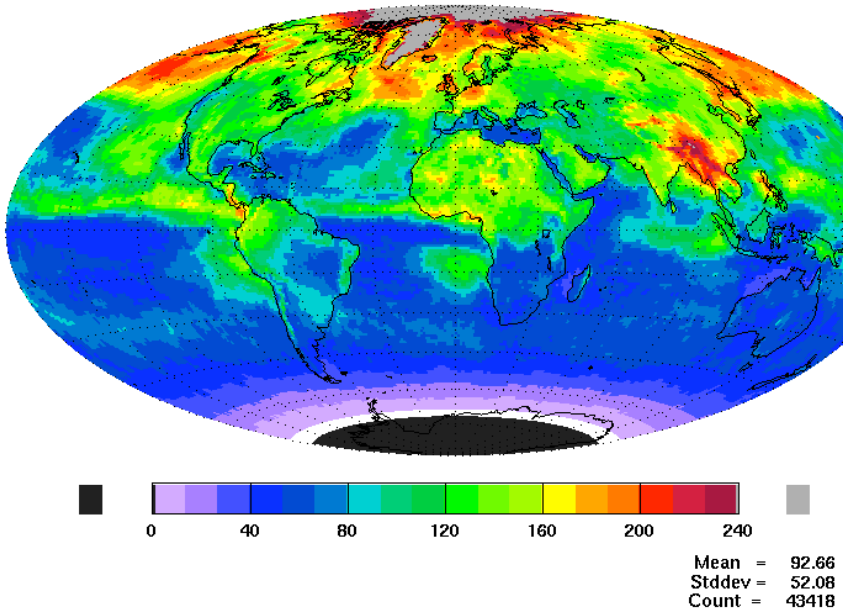


# TSI 200207 Shortwave TOA Reflected Total Sky Monthly Mean




SRBAVG:Total-sky TOA SW Flux – GEO Interpolation

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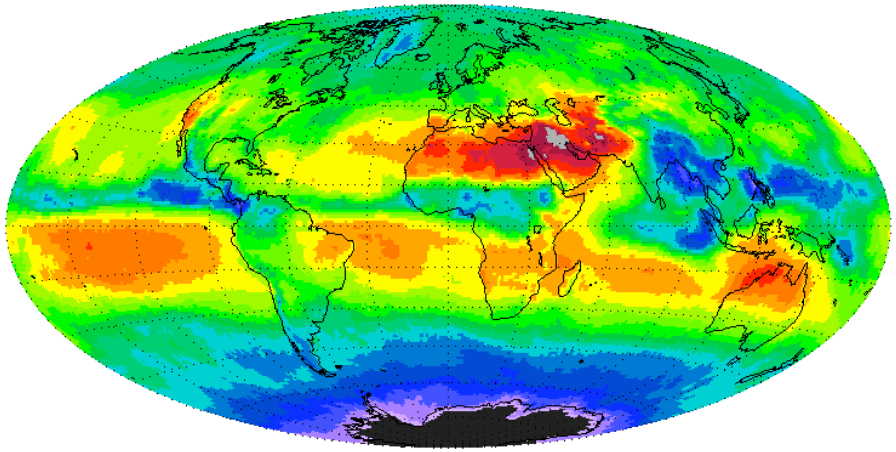
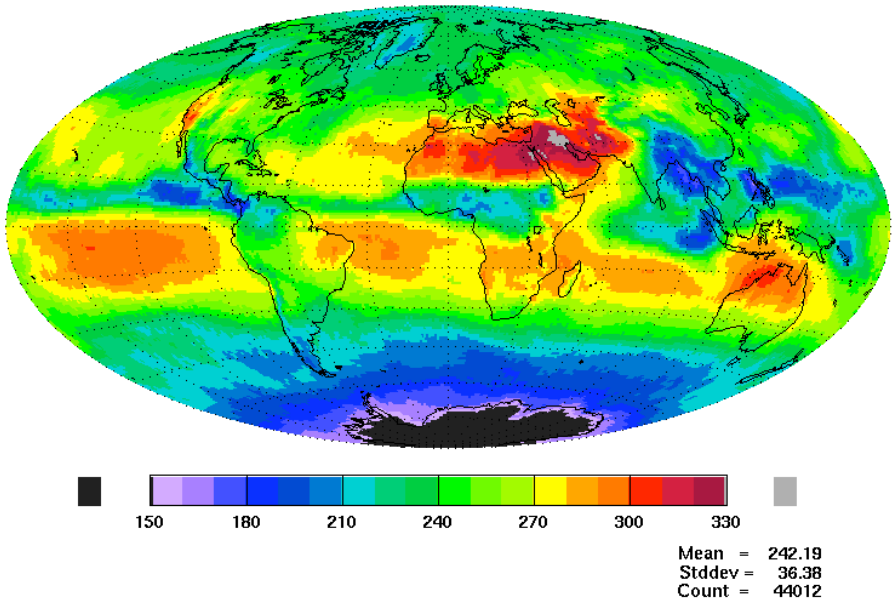
# TSI 200207 Outgoing Longwave Total Sky Monthly Mean




SRBAVG: Total-sky TOA LW Flux – GEO Interpolation

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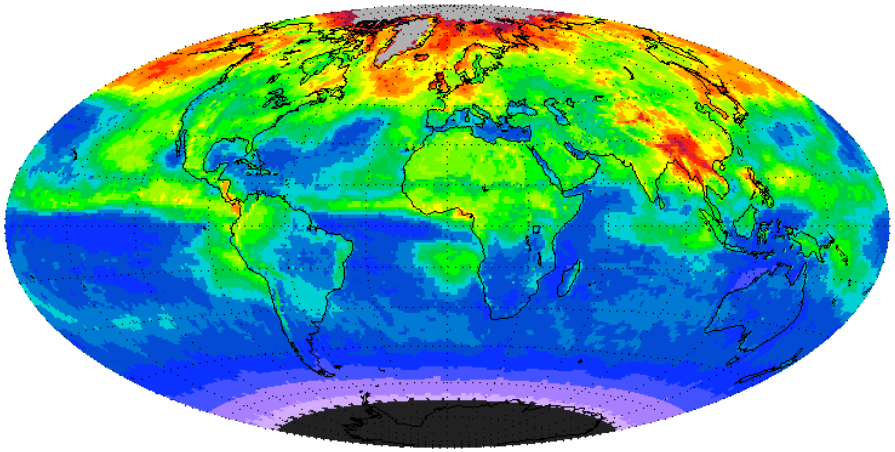
## SYNI 200207 UNTuned Shortwave TOA Reflected Monthly Mean

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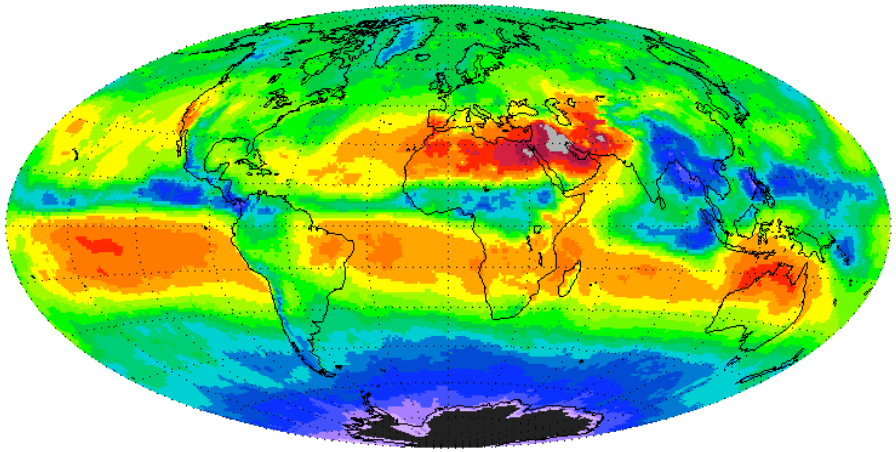
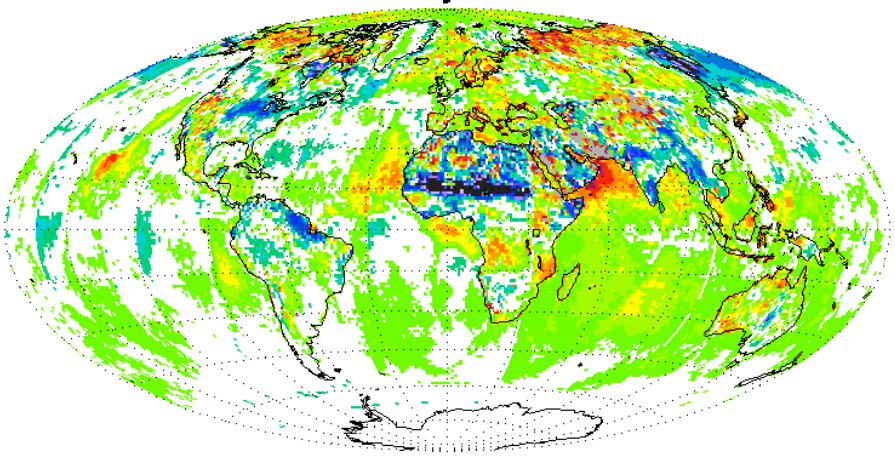
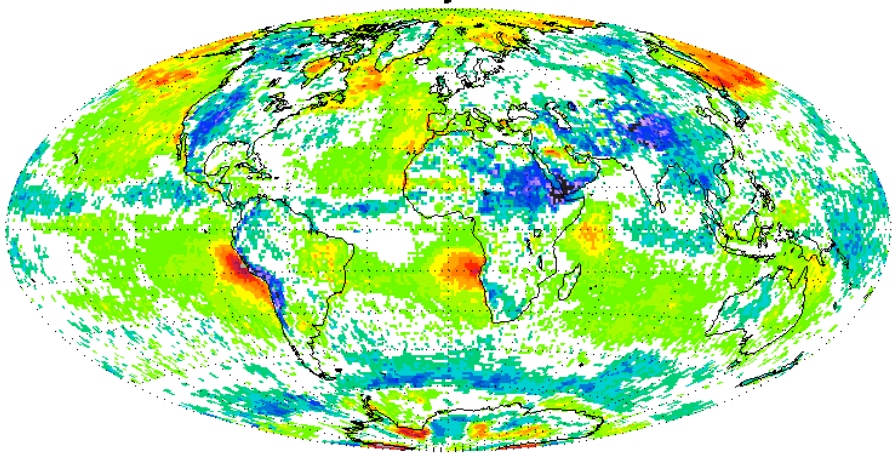



## YNI 200207 UNTuned–Obs Shortwave TOA Reflect Monthly Mean




## SYNI 200207 UNTuned–Obs Longwave TOA Monthly Mean

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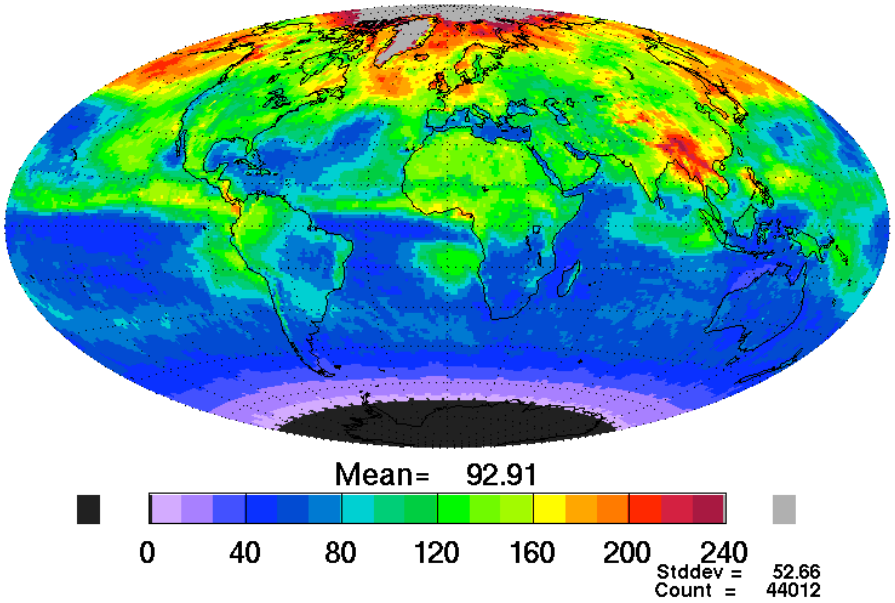


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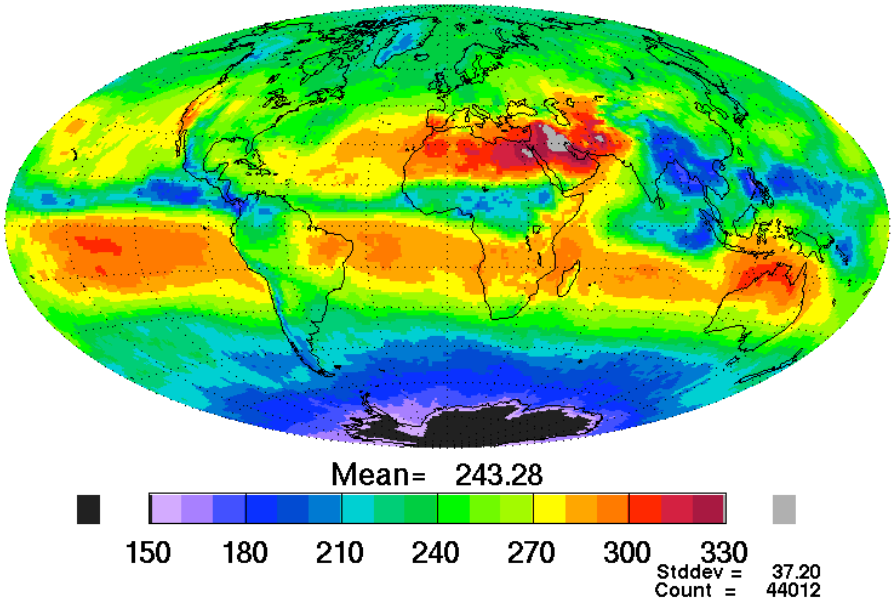


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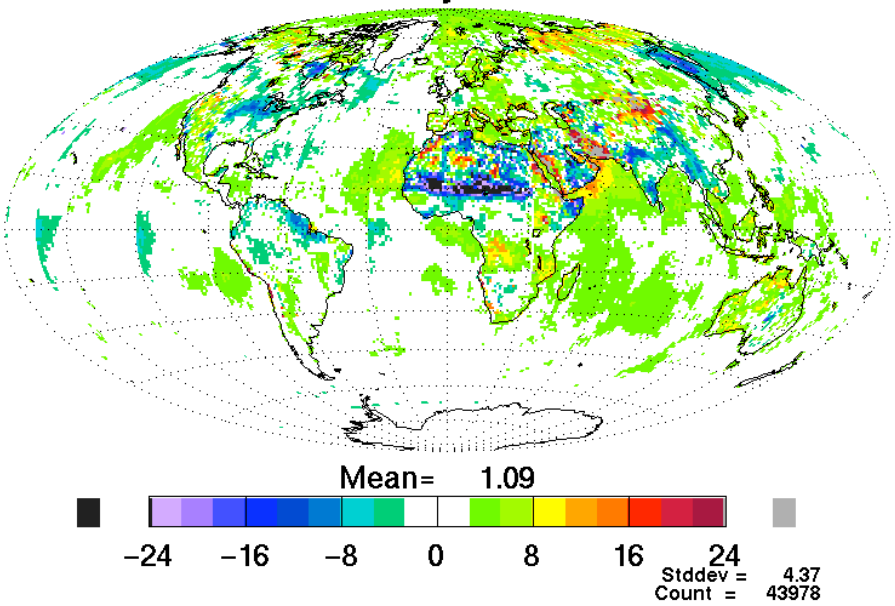
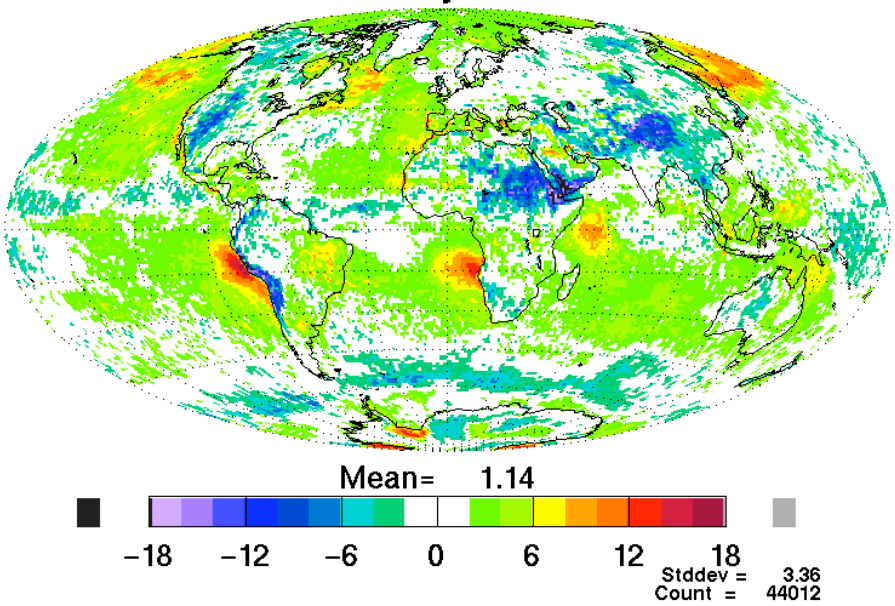



## SYNI 200207 Tuned–Obs Longwave TOA Monthly Mean

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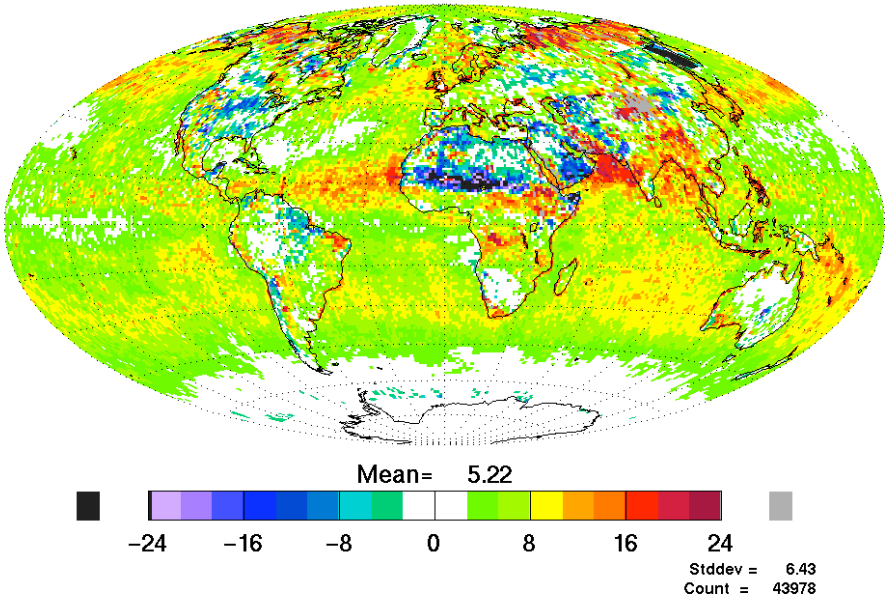
## SYNI 200207 UNTuned-Obs Shortwave TOA Reflected Monthly Mean (CERES)

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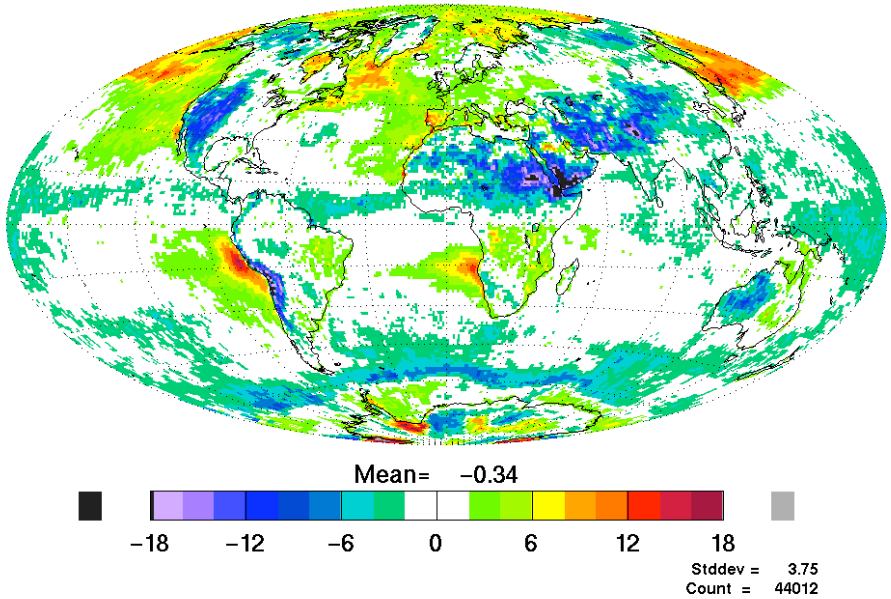


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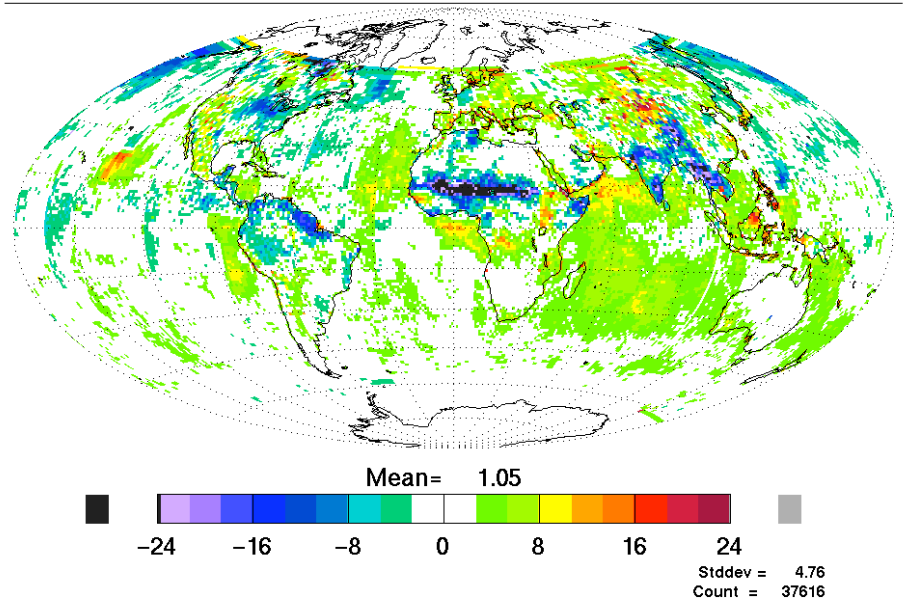


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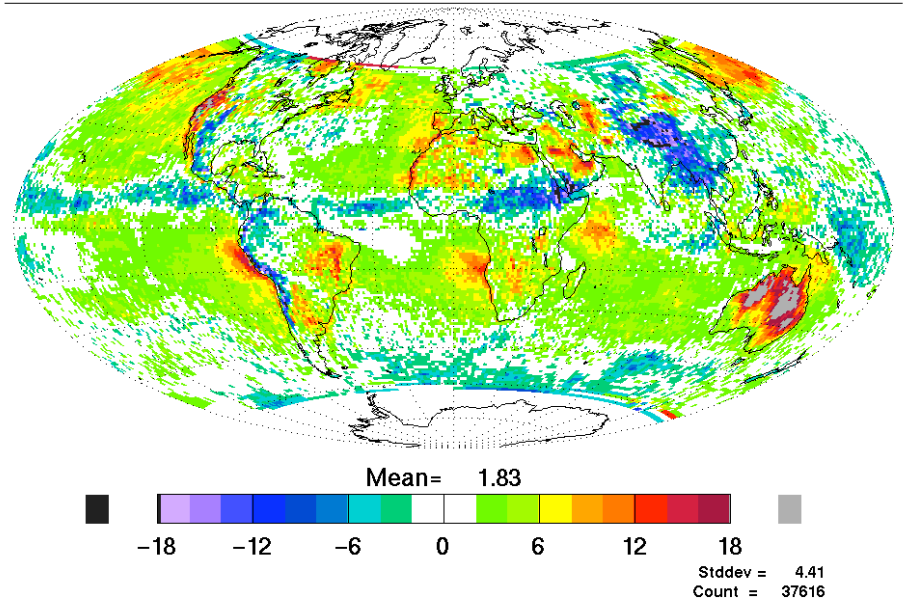

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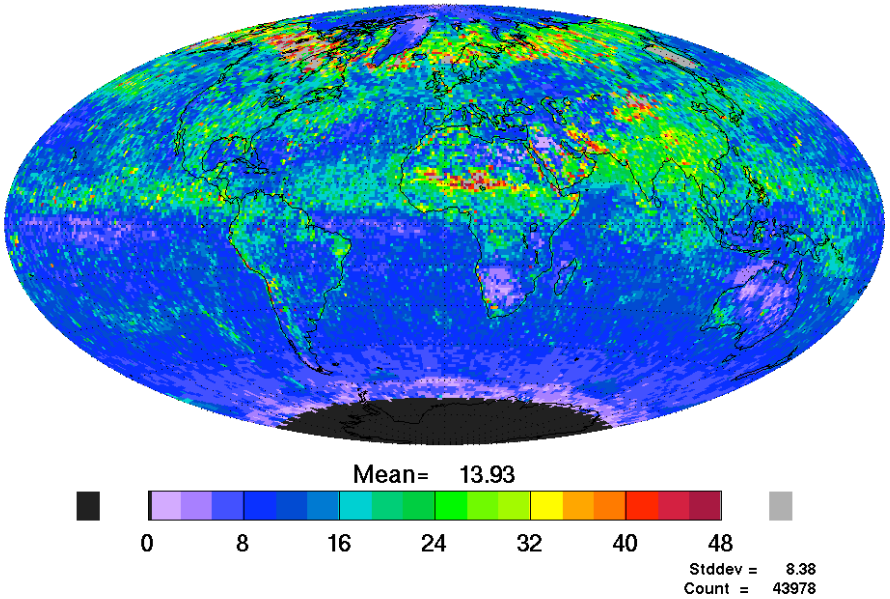


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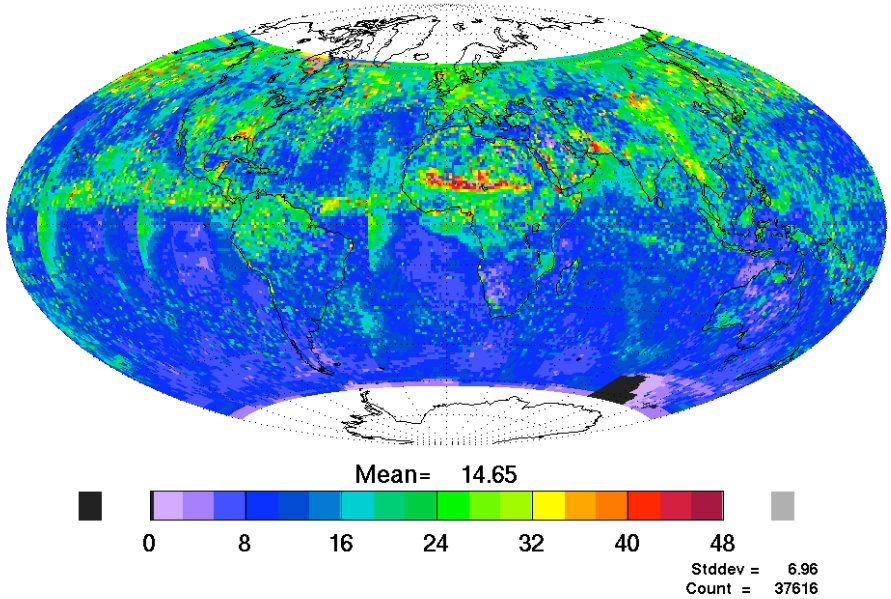


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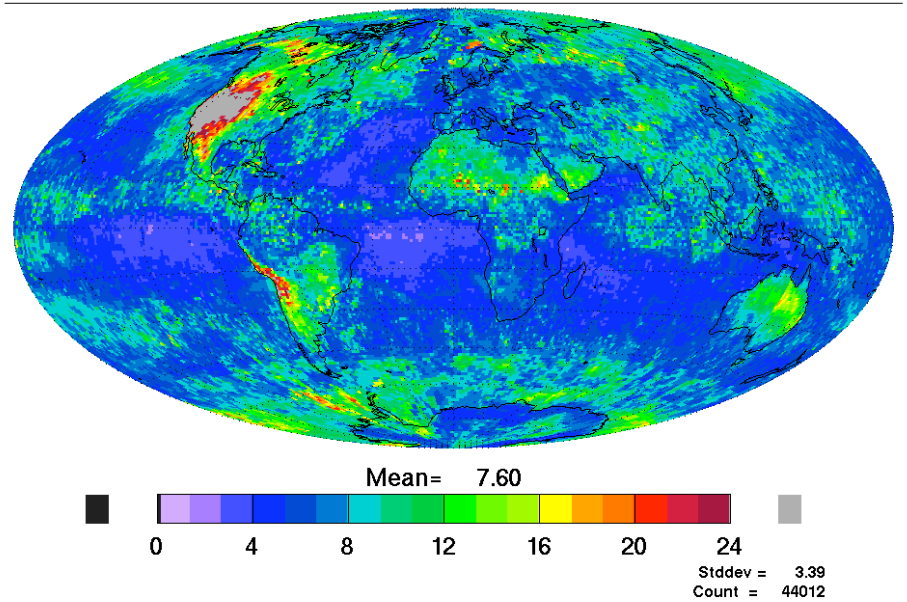




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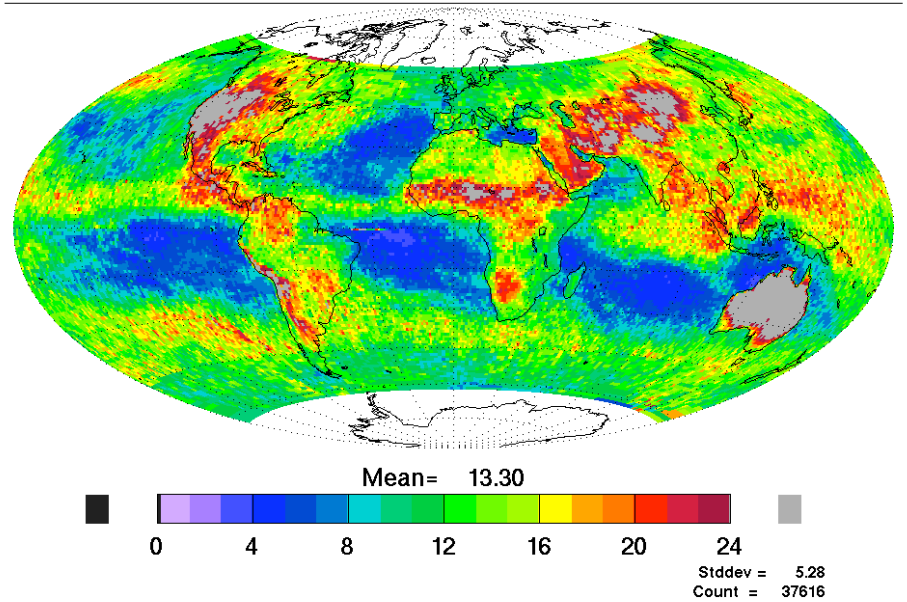
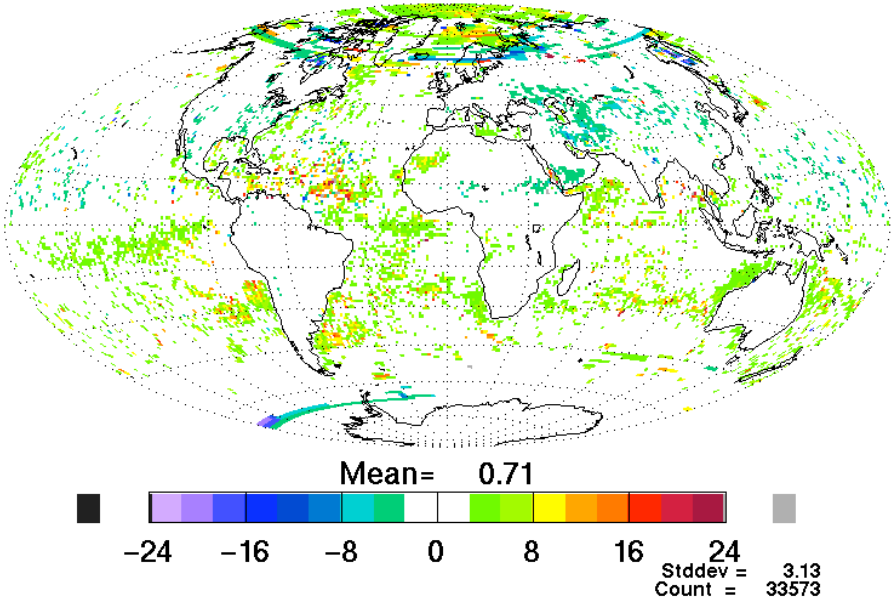
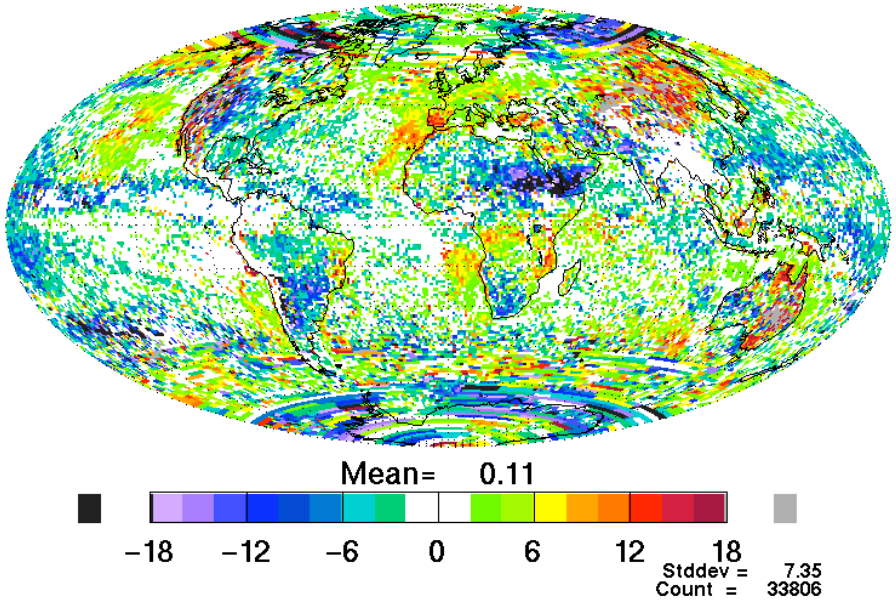


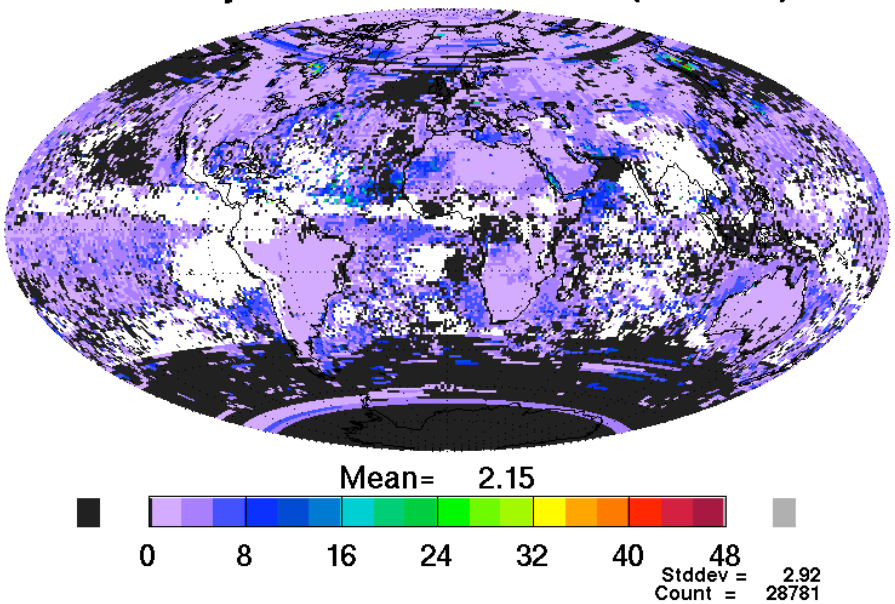
## YNI 200207 UNTuned-Obs Shortwave TOA Reflect
## Monthly Mean (CLEAR)



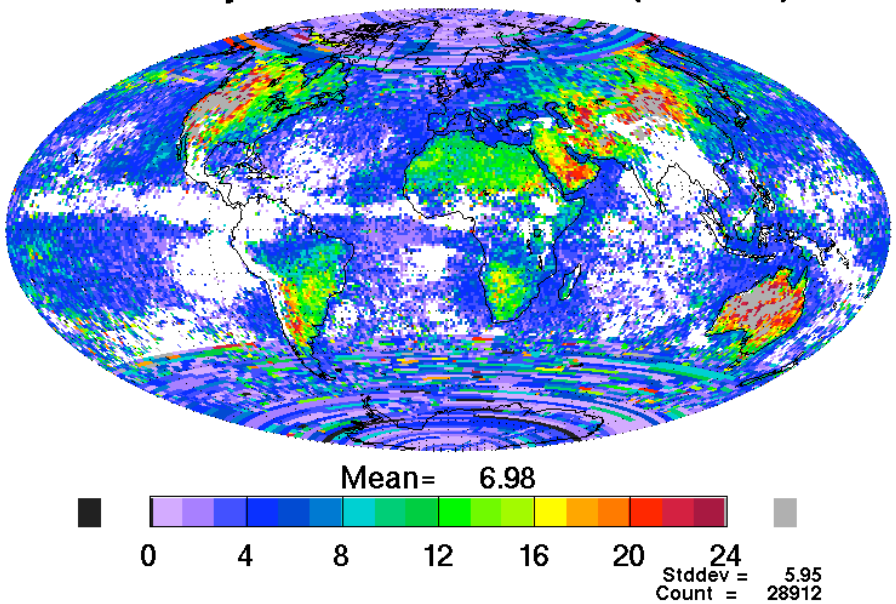

## SYNI 200207 UNTuned-Obs Longwave TOA
## Monthly Mean (CLEAR)



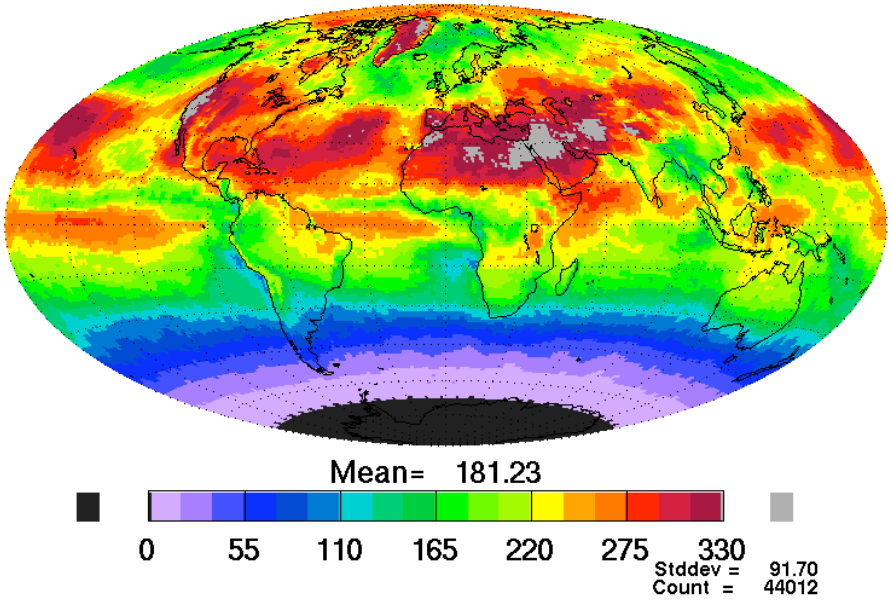

## YNI 200207 UNTuned-Obs Shortwave TOA Reflect
## Monthly Standard Deviation (CLEAR)



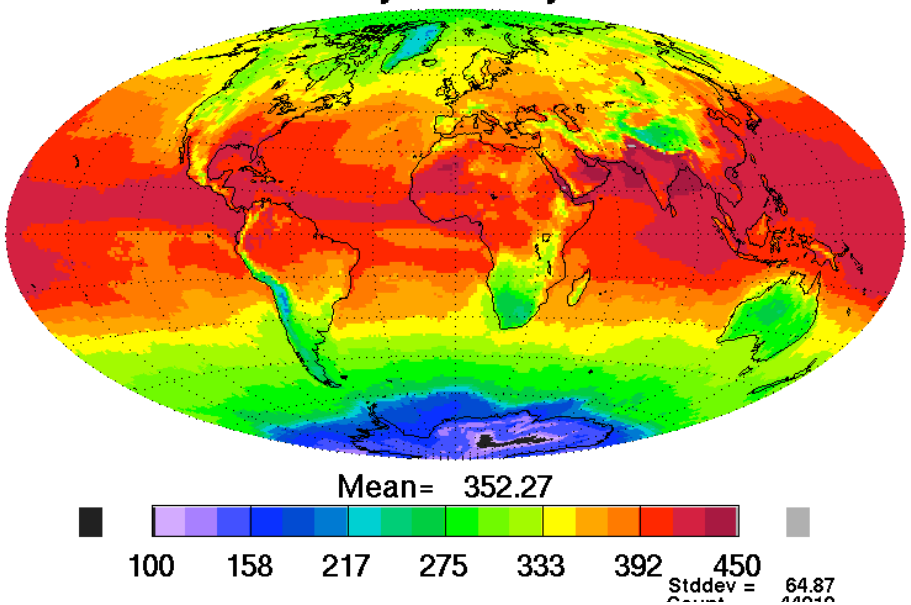

## SYNI 200207 UNTuned-Obs Longwave TOA
## Monthly Standard Deviation (CLEAR)



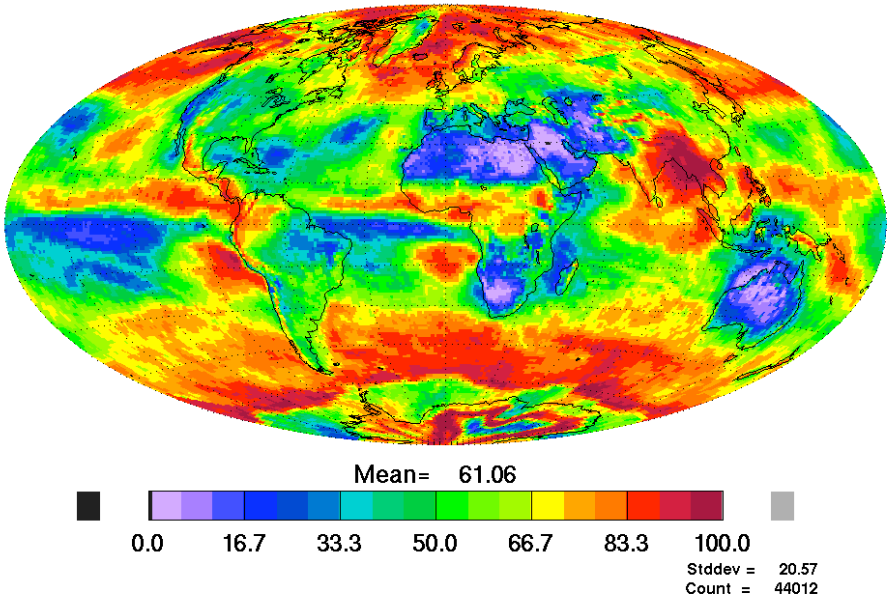
## SYNI 200207 UNTuned Surface SW Down Total Sky Monthly Mean



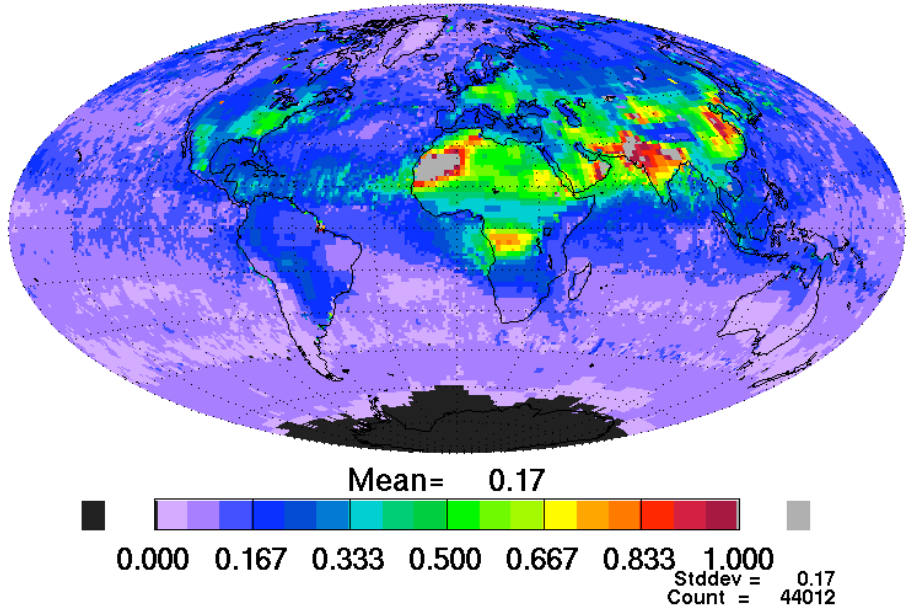

## SYNI 200207 UNTuned Surface LW Down Total Sky Monthly Mean



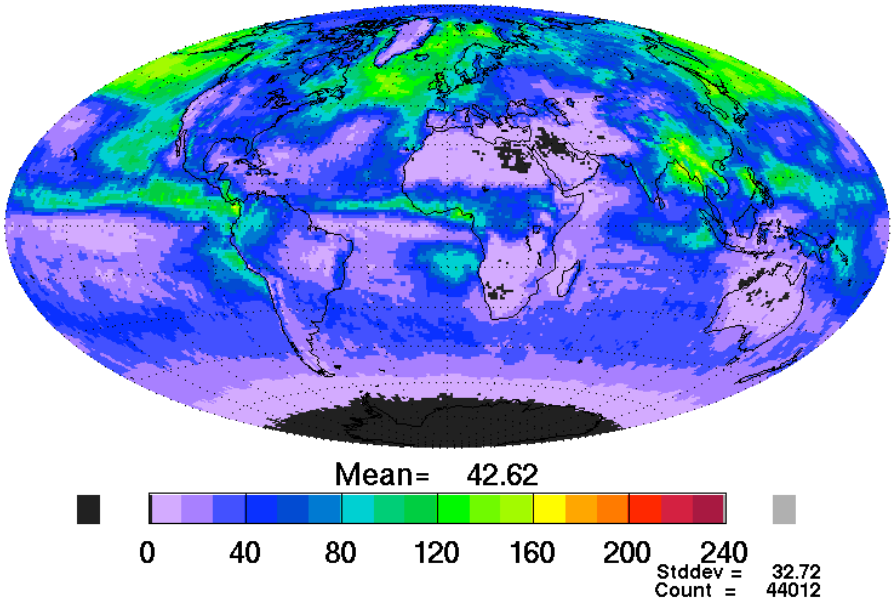

## SYNI 200207 Total Cloud Area %



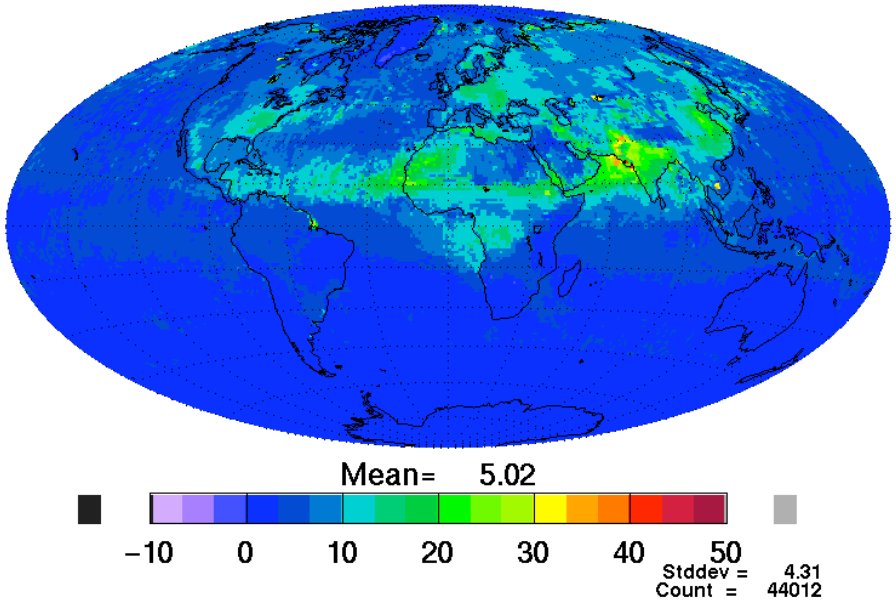

## SYNI 200207 Inital Aerosol Optical Depth



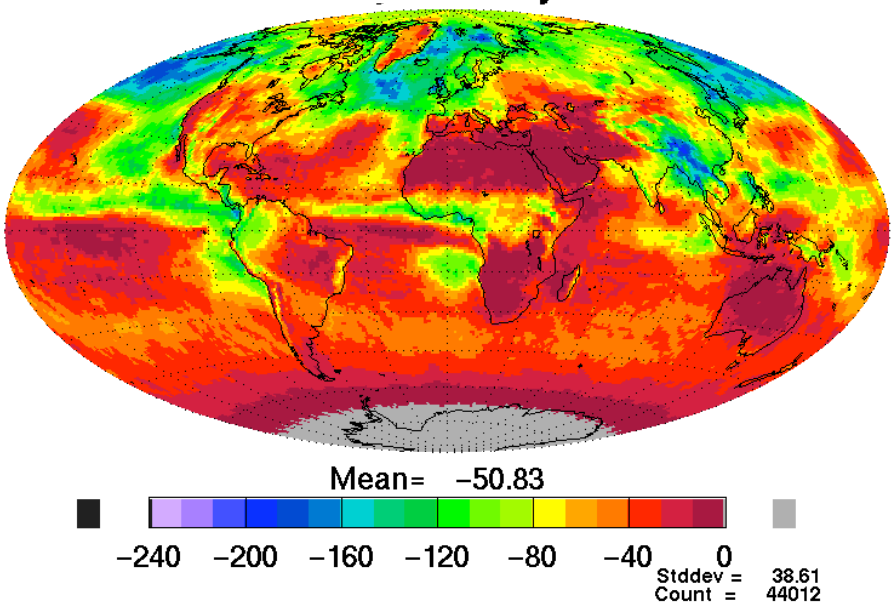
## SYNI 200207 TOA SW Cloud Forcing Monthly Mean



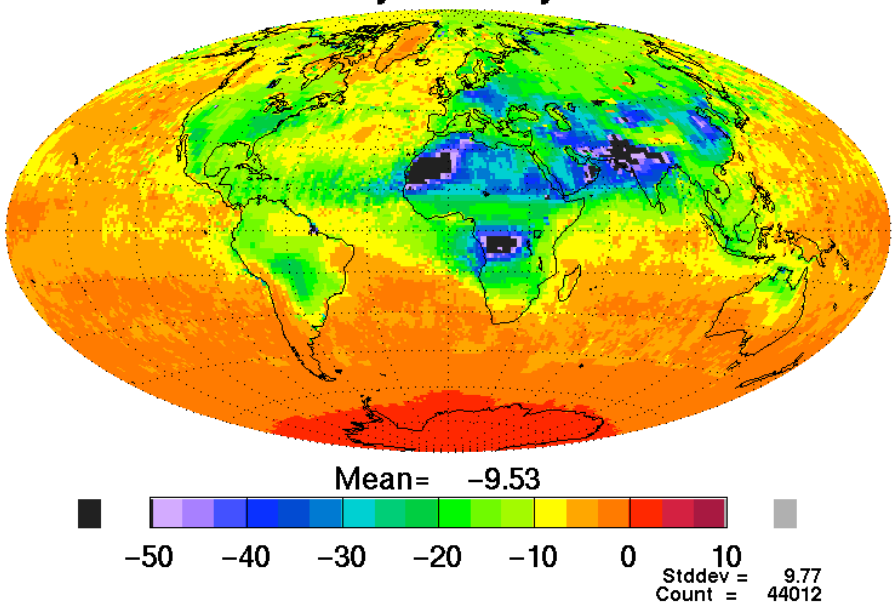

## SYNI 200207 TOA SW Aerosol Forcing Clear Sky Monthly Mean




## SYNI 200207 SFC SW Cloud Forcing Monthly Mean




## SYNI 200207 SFC SW Aerosol Forcing Clear Sky Monthly Mean



# Summary

- First Run
- Has Known Problems
- Encouraging regardless
- Major cross group interfaces resolved